DOCUMENT RESUME

ED 065 507 TM 001 427

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TITLE Development of a Work Sample Criterion for General Vehicle Mechanic.
INSTITUTION Human Resources Research Organization, Fort Knox, Ky. Div. 2.
SPONS AGENCY Office of the Chief of Research and Development (Army), Washington, D.C.
REPORT NO TR-70-11
PUB DATE Jul 70
NOTE 39p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Auto Mechanics; *Criterion Referenced Tests; Equivalency Tests; Item Analysis; *Measurement Techniques; *Performance Tests; Questionnaires; Research Methodology; Skill Analysis; Task Performance; *Test Construction; Test Reliability; Test Results
IDENTIFIERS *JOBTEST 1

ABSTRACT

A work sample criterion test was developed for General Vehicle Repairman, MOS 63C30 and 63C40. Test items covered three task categories: troubleshooting, corrective action, and preventive maintenance. Thirty-eight organizational mechanics were tested at Fort Knox, Kentucky. Data were also collected on the quality of performance, for example, use of good procedures, use of test equipment, and so forth. The study indicated that (a) the test appears to have a high degree of reliability (r=.82), (b) on the average, 60% of the test exercises were successfully completed by the 38 mechanics, (c) there was a moderate relationship between performance and length of experience, and (d) there were indications of lack of use and unfamiliarity with technical publications, and also a lack of skill in the use of special tools and equipment. (Author)

ED 065507

Technical Report 70-11

Development of a Work Sample Criterion for General Vehicle Mechanic

by

John D. Engel

HumRRO Division No. 2

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July 1970

Prepared for:

Office, Chief of
Research and Development
Department of the Army

Contract DANC 19-70-C-0012

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HumRRO Division No. 2
Fort Knox, Kentucky

HUMAN RESOURCES RESEARCH ORGANIZATION

Technical Report 70-11
Work Unit JOBTEST
Sub-Unit I

The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Published
July 1970
by
HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street
Alexandria, Virginia 22314

Distributed under the authority of the
Chief of Research and Development
Department of the Army
Washington, D.C. 20310

FOREWORD

The major long-term objective of Work Unit JOBTEST is to investigate and evaluate a variety of concepts and procedures for the measurement of job performances. Emphasis will be placed on identifying those techniques that have both validity and utility in practical testing environments and that have generality across groups of tasks.

JOBTEST I was concerned with the development of a "hands-on-equipment" work sample criterion in the area of automotive maintenance. This report describes the results of this work. In addition, information was gathered concerning the present level of performance of general vehicle repairmen, MOS 63C30 and 63C40. The research was performed and most of the report preparation completed while HumRRO was part of The George Washington University.

The research reported here is from the first of a series of studies. Subsequent experimental work will concern other measurement techniques in relation to the present work sample criterion test.

JOBTEST I was conducted during 1968 at HumRRO Division No. 2, Fort Knox, Kentucky, under Dr. Donald F. Haggard as Director. The Work Unit Leader is Mr. John D. Engel.

Military support for the Work Unit is provided by the U.S. Army Armor Center and by the U.S. Army Armor Human Research Unit; the Military Chief of the Unit is LTC John A. Hutchins. SP5 Robert Rehder of the Armor HRU served as research assistant in the study.

HumRRO research for the Department of the Army is conducted under Contract DAHC 19-70-C-0012. Work Unit JOBTEST is conducted under Army Project 2Q062107A712, Training, Motivation, and Leadership Research.

Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

The Enlisted Personnel Management System is one of the largest Army users of proficiency tests. These tests are used to help implement many Army personnel programs, such as the proficiency pay and MOS qualification programs.

The Board of Inquiry on the Army Logistics System (Brown Board) and other surveys of maintenance activities have raised questions about the validity of proficiency measures used in the awarding of MOSs and proficiency pay for the automotive mechanic. It is considered likely that the method of proficiency measurement most commonly employed—paper-and-pencil examinations—limits the validity of proficiency assessment that may be achieved in evaluating certain types of tasks.

RESEARCH PROBLEM

The major long-term research problem in Work Unit JOBTEST is to study and evaluate a variety of concepts and procedures for the measurement of job performance. Emphasis will be placed on identifying those techniques that have both validity and utility in practical testing situations, and that have generality across groups of tasks.

The first phase of the research, and the primary problem dealt with in this report, is the development of a relevant and reliable work sample criterion for the General Vehicle Mechanic. This criterion will be used as a standard in later research phases that will evaluate various measurement techniques.

During the development of the criterion, a secondary objective was to collect information on the quality of performance of organizational maintenance by general vehicle repairmen.

METHOD

Work was begun by updating job information in a 1964 HumRRO analysis of job requirements for consolidated MOS 630, 631, 632 (Automotive Mechanic). This updated job requirements inventory was used as a basis for developing items for a "hands-on-equipment" work sample.

A four-day proficiency test consisting of 33 sample exercises was constructed. The test included a diagnostic scoring procedure for use in scoring men on quality of performance. The exercises were individually performed on track and wheel vehicles in common use and were individually scored by experienced mechanics who had been trained in proper test administration procedures.

The test was administered to a total of 38 organizational mechanics, drawn from all the organizational maintenance units at Fort Knox, Kentucky. In addition, a questionnaire was used to obtain information on personnel data, organizational maintenance experience, experience on various vehicle systems, current job assignment, type and amount of training, and amount of supervision received on the job.

RESULTS

(1) The item analysis values for the test were found to be well within accepted ranges for this type of data analysis. These analyses dealt with the difficulty level of the

items and their ability to discriminate between subjects who were high and low on the total pool of items.

(2) The total test appears to have a high degree of reliability (r=.82), indicating it should permit a high degree of accuracy of measurement when used as a criterion in evaluating other measurement techniques.

(3) On the average, 60% of the exercises were successfully completed by the 38 mechanics.

(4) There was a moderate relationship between performance and length of experience.

(5) There was no practical difference in performance among mechanics with different types of training (e.g., service school, other school, on-the-job).

(6) Lack of use and unfamiliarity with technical publications, and lack of skill in the use of special tools and equipment were significant correlates of low proficiency.

CONCLUSIONS

(1) The work sample criterion appears to be a reliable and job relevant measure that may be used as a standard for the evaluation of other measurement techniques.

(2) The results of this study indicate that the development of a proficient, well-trained mechanic is extremely complex, and that a more detailed examination should be made in the areas of training for troubleshooting tasks (as these appear to be the most difficult tasks to perform) and training in the use of technical publications and test equipment.

CONTENTS

Page

Introduction 3
- Military Problem 3
- An Overview of Proficiency Measurement Techniques 3
- Research Problem 5
- Approach 6

Method 6
- Subjects 6
- Equipment, Materials, and Research Personnel 7
- Test Development 7
- Test Item Format 8
- Test Administrator Training 9
- Test Administration 9
- Test Scores and Personnel Data 10

Results 10
- Test Characteristics 10
  - Item Analysis 10
  - Test Reliability 12
- Performance of Organizational Maintenance by General Vehicle Repairmen 13

Discussion and Observations 16

Literature Cited 21

Appendices

A Proficiency Test for General Vehicle Repairman: List of Exercises 23

B Proficiency Test for General Vehicle Repairman: Sample Exercise 25

C Proficiency Test for General Vehicle Repairman: Sample Summary Performance Checklist 26

D Proficiency Test for General Vehicle Repairman: Sample Organizational Maintenance Personnel Inventory 27

E Difficulty Level (P) and Discrimination Index (r_b) of Test Items for the Total Test and Subtests 29

Tables

1 Number of Subjects Tested in Each MOS by Type of Training and Years of Experience . . 6

2 Range and Mean Difficulty Level (P) Values for Various Groups of Test Items 11

3 Range and Mean of the Discrimination Indices Between Test Items and Various Test Scores 11

4 Average Difficulty Level (P) and Mean Scores for Half Tests 12

5 Mean Test Performance by MOS and Total Group 13

6 Correlation Between Work Sample Test Scores and Length of Experience 14

7 Mean Test Performance by Various Types of Training 14

Tables

Page

8 Tests of Differences Between the GT and MM Means for Upper and Lower Performance Groups 15
9 Test Item Performance in the Descriptive Pass-Fail Categories 15
10 Percent of Test Items in Which "Required" Procedures Were Used by High and Low Performance Groups 15
11 Percent of Test Items in Categories of Test Equipment Usage for High and Low Performance Groups 16
12 Percent of Test Items in Categories of Publications Usage for High and Low Performance Groups 16

Development of a Work Sample Criterion for General Vehicle Mechanic

INTRODUCTION

MILITARY PROBLEM

A primary reason for the use of proficiency tests in the U.S. Army is to support the implementation of certain portions of the Enlisted Personnel Management System. The Management System, in turn, was devised to implement certain portions of the mission of the Deputy Chief of Staff for Personnel, Department of the Army (DCSPER), specifically DCSPER's responsibility for "development and administration of a military personnel management system, to include policies and programs for procurement, individual training (less foreign military training), education, retention, career development, distribution, promotion, and separation of military personnel . . ."(1) The present study is based on a requirement from DCSPER.

One of the largest users of proficiency tests is the Enlisted Personnel Management System. A survey by the Board of Inquiry on the Army Logistics System (Brown Board) and other surveys of maintenance activities have raised questions about the validity of the proficiency measures and performance standards employed in the Enlisted Evaluation System's MOS evaluation.

These MOS evaluation results are used in numerous Army personnel programs, some examples of which are:

(1) Proficiency pay programs: MOS evaluation is designed to provide incentives to keep qualified soldiers with critical occupational skills.

(2) MOS qualification: MOS evaluation provides for the verification of each soldier's job proficiency.

(3) Secondary MOS qualification: MOS evaluation ensures that the soldier has maintained his job proficiency depth in effective assignment and utilization actions.

(4) Reserve and National Guard: Annual MOS evaluations of Reserve Component Unit Personnel help ascertain the readiness posture of our civilian soldiers.

(5) Promotion qualification: MOS evaluation is geared to determine the enlisted man's promotion qualification. The use of the promotion qualification score as a criterion for promotion is mandatory.

(6) Enlisted grade and MOS determination: MOS evaluation is used to determine enlisted grade and MOS for those officers and warrant officers who are released from active duty in their commissioned or warrant officer status and enlist in the Regular Army.

In general, the Enlisted Personnel Management's Enlisted Evaluation System needs job proficiency tests that have a high degree of validity and reliability, and that are as inexpensive to develop and administer as possible (consonant with standards of validity and reliability), in order to effectively implement several portions of the Army's personnel program.

AN OVERVIEW OF PROFICIENCY MEASUREMENT TECHNIQUES

There are various types of proficiency measurement techniques that might be used to evaluate a man's achievement. According to Glaser and Klaus (2), proficiency measurement techniques may be grossly categorized on the basis of their remoteness from actual

job performance. This remoteness may be due to differences in (a) the behavior elicited for measurement, (b) the eliciting stimuli themselves, or (c) both stimulus and behavior. In most instances, however, as the test stimuli become more remote from those found in the actual job situation, the responses elicited are likewise less similar to those found in job performance.

Thus at one extreme along this continuum of remoteness is the measurement of proficiency during actual job performance. At the other extreme are measures (e.g., paper-and-pencil tests) that are not obviously similar to the criterion task, but assess performance at tasks that correlate with on-the-job behavior.

Between these two extremes are test situations that (a) call for the performance of the actual job task outside the real job environment, or (b) attempt to simulate the job task while at the same time offering effective control of the factors that in "real" situations are likely to interfere with reliable and valid measurement. The four major segments along this continuum can be identified as (a) on-the-job measures, (b) work sample measures, (c) simulated-job measures, and (d) correlated-job measures.

In principle, proficiency measurement should be accomplished during a man's typical performance, under conditions generally present during day-to-day operations. This method, however, presents a number of problems. The degree of control that can be achieved in a job situation is generally less than satisfactory for obtaining reliable measurements. In addition, attempts to standardize the situation for proficiency-measurement purposes frequently introduce considerable artificiality into the situation. Finally, the consideration of committing large amounts of time, money, and men to the testing situation often makes this an impractical method of assessment.

To reduce, to some extent, the problems involved in on-the-job measures, samples of the actual job tasks involved may be removed from the real job environment so they can be readily and reliably assessed. This type of proficiency measurement technique is referred to as a work sample test. Here, the individual performs the actual tasks but not in the real job environment. This technique is a close approximation to on-the-job measures, but it has some of the same drawbacks: It is costly, time consuming, and essentially impractical as a method of assessing large numbers of people.

Because it is difficult to measure men's proficiency during actual job and work sample situations, the job must be simulated in a controlled manner in order to produce a reliable and valid, yet practical method of performance assessment. The essence of task simulation is the design of test stimuli that will evoke joblike responses that can be measured objectively. This general category of simulated-job measures includes a variety of proficiency measurement techniques. Some of the most frequently employed measures use equipment mock-ups and simulators.

An extreme position along the dimension of remoteness from job reality is represented by tests measuring, not job behaviors themselves, but correlated-job behaviors—i.e., measures correlated with job behavior. These measures are the most remote from the actual job situation. The most widespread type of correlated-job measure is verbal response as used to assess skills that are substantially nonverbal. Examples of this type of proficiency measure are tests of job knowledge, vocabulary, and nomenclature used to evaluate performance at procedural and manipulative tasks. Other types of correlated-job measures are those that involve a deliberate modification in the response made so as to facilitate the recording and evaluation of responses. A common example of this kind of construction is multiple-choice paper-and-pencil tests that are used to measure the ability to produce appropriate responses by measuring ability to recognize them. Because they are easily constructed, inexpensive, and easily administered, paper-and-pencil tests of job knowledge are frequently used to evaluate an individual's proficiency.

However, tests measuring knowledge of technical information, tool nomenclature, technical vocabulary, or underlying theory may not relate to actual performance for some

tasks. Instead, they measure verbal knowledge about the job, and therefore assess behaviors which, at best, may be correlated only slightly with actual job behavior—especially if the job depends on motor and manipulative skills.

It is thus likely that paper-and-pencil tests, the kind of proficiency measurement most commonly employed, limit the validity of the evaluation of proficiency for certain tasks. Two examples are summarized below.

(1) The U.S. Army Enlisted Evaluation Center conducted a validation study of the paper-and-pencil evaluation test for Track Vehicle Mechanic, MOS 63C20 (Yellen, 3). Performance of duties in this MOS is heavily dependent on perceptual-motor skills. The criterion used in the study was the average co-worker rating rendered by three enlisted men for each of the 47 enlisted men in the validation sample. The following conclusions were drawn from the study: "(a) The total evaluation test had a validity coefficient of .21; (b) optimal weighting of the Broad Subject Matter Areas did not significantly increase the validity of the total evaluation test."

It should be noted that a validity coefficient r of .21 is not statistically significant, but even if it were, it is far too low for use in group measurement and grossly inadequate for use in individual measurement.

One reason for the lack of validity could be that an examination can differentially affect scores because of factors unrelated to actual job performance. The test may lean heavily, for example, on the individual's ability to understand test directions or on his speed in reading lengthy descriptive passages. The influence of verbal facility on the test score appears to distort proficiency estimates in such a way as to systematically penalize those with poor vocabularies and reading skills, and not to reflect their proficiency in tasks that do not depend directly on verbal skills.

(2) The Enlisted Evaluation Center conducted a validation study of the paper-and-pencil evaluation test for Personnel Specialist, MOS 716.1 (Urry, Shirkey, and Nicewander, 4). In this MOS, performance of duties is heavily dependent on verbal and reasoning skills, in definite contrast to the previous case in which perceptual-motor skills were predominant. Again, the criterion used in the study was the average co-worker rating rendered by three enlisted men for each of the 55 enlisted men included in the validation sample. The following conclusions were drawn from the study: "(a) The total evaluation test had substantial validity—the validity coefficient was .50; (b) optimal weighting of BSMAs did not increase the validity of the total evaluation test."

It should be noted that a validity coefficient r of .50 is sufficiently high for practical application in group measurement.

One reason for the validity of the test for Personnel Specialists may be the fact that the test leans heavily upon the same skills that are required in the job—both the test and the job rely directly on verbal and reasoning skills. Therefore, in this instance a paper-and-pencil test seems to be appropriate for measuring performance in the MOS.

RESEARCH PROBLEM

The long-range research problem of Work Unit JOBTEST is to study and evaluate a variety of concepts and procedures for the measurement of job performance. Emphasis will be placed on identifying those techniques which have both validity and utility in practical testing environments, and which have generality across groups of tasks.

The primary research problem dealt with in this report was to develop a relevant and reliable work sample criterion, which may be used as a standard against which all techniques will be evaluated. A secondary aspect deals with obtaining information about the quality of performance of organizational maintenance by general vehicle repairmen.

APPROACH

A two-step approach was taken in order to achieve the long-range research objective. This report deals with the first step or the immediate research objective, that is, the development of a reliable work sample for assessing on-job performance, since performance on the job must serve as the criterion for the validation of other assessment techniques.

The second step will be concerned with the research and development of a range of proficiency measurement techniques varying in degree of remoteness from the work sample. These techniques will be compared with the work sample standard (as described in this report) on the basis of reliability, validity, ease of manufacture, application, and cost.

METHOD

SUBJECTS

The G3 Personnel Section at Fort Knox, Kentucky, assigned 38 organizational mechanics from the available manpower in the various organizational maintenance units there. The selection was further based on MOS Code, and every effort was made by G3 to obtain men with varying degrees of experience and training within the 63C30 and 63C40 MOS Codes. Fifteen men held the MOS Code 63C30 and 23 the Code 63C40 (see Table 1). The subjects were divided into four groups—two of 63C30s and two of 63C40s, each group being tested for four days.

Table 1

Number of Subjects Tested in Each MOS by Type of Training and Years of Experience

Type of Training and MOS	Experience (years)					Total
	0-1	1-5	5-10	10-15	15 or More	
Service School						
MOS 63C30	0	0	2	0	0	2
MOS 63C40	0	3	2	2	0	7
Other School						
MOS 63C30	1	3	1	0	0	5
MOS 63C40	0	2	2	3	3	10
Service and Other School						
MOS 63C30	1	5	0	1	0	7
MOS 63C40	1	0	0	1	0	2
On-the-Job						
MOS 63C30	0	1	0	0	0	1
MOS 63C40	0	2	1	0	1	4
Total	3	16	8	7	4	38

EQUIPMENT, MATERIALS, AND RESEARCH PERSONNEL

Test problems were set into the following vehicles:

Quantity	Type	
3	M60	tanks
6	M151A1	¼-ton trucks
2	M54A2	5-ton trucks
1	M35A1	2½-ton truck
1	M88	recovery vehicle
1	M110	self-propelled artillery vehicle
1	M113	armored personnel carrier
3	M108	self-propelled artillery vehicles
Total 18		

Two large maintenance shops, each with two indoor and three outdoor bays, were used as testing facilities.

Each man was provided with a mechanic's tool kit, relevant technical manuals, troubleshooting guides, and test equipment. Test item sheets, scoring sheets, and a biographical questionnaire were developed (copies of these items are shown in Appendices A through D).

Ten mechanics, E5 or higher, with the MOS Code 63C30 or 63C40, were trained to be test administrators. In addition, one noncommissioned officer in charge (NCOIC), one warrant officer, and one civilian researcher formed the research team and were responsible for the testing.

TEST DEVELOPMENT

A task inventory was necessary, to serve as a basis for future comparisons and as a reference for the development and evaluation of new performance measures. Such a task inventory had been completed at HumRRO Division No. 2 in March 1964, and it was considered sufficiently detailed and inclusive to warrant updating and use for the present study.[1]

Three senior automotive mechanics, with ten or more years of experience, served as technical advisors to review and update the 1964 inventory, with the constraints that (a) only task categories pertaining to individual (as opposed to group) performance were to be considered; and (b) only job level "2" tasks (defined in the task inventory as essentially journeyman level tasks) were to be included.

These constraints delimit the study and focus on tasks to be undertaken by journeymen—the level at which the mechanic is first responsible for performance of the full spectrum of organizational maintenance tasks.

In the review and alteration of the Smith inventory, each of the three technical advisors was given a copy of the complete inventory and asked to pencil in any revisions deemed necessary in his independent appraisal. The reports were then combined for comparison, and the technical advisors' modal responses were annotated for each area.

On the basis of the information gathered (5), activities to be tested were selected from three task categories: (a) troubleshooting, (b) corrective action, and (c) preventive maintenance. In addition, examination of the task inventory showed that approximately

[1] The analysis for the task inventory was performed by Dr. John P. Smith.

60% of the vehicle systems on which the *individual* journeyman mechanic worked contained troubleshooting tasks; 35% of the vehicle systems on which the *individual* worked contained corrective action tasks; and 5% of the vehicle systems on which the *individual* worked contained preventive maintenance tasks.

Test problems were drafted by one automotive Warrant Officer and two E7 mechanics. Each man drafted 11 test items that were based on tasks he chose because of his expertise in specific automotive areas. These test items were drafted using the information provided in the job requirements inventory and the following criteria:

(1) All items were to cover *individual* (as opposed to group) task categories of the journeyman level mechanic.

(2) Problems covering the various task categories were to be represented in approximately the same proportion as the task categories occur in the job requirements inventory.

(3) Approximately half of the items were to deal with wheel vehicle maintenance, the other half with track vehicle maintenance.

(4) The task which the item was based on should be critical. That is, (a) without proper maintenance of part or system, vehicle could not maintain "combat readiness" (i.e., the vehicle must be able to make a trip of approximately 85 miles in not more than 15 hours); (b) if malfunction were not properly identified and diagnosed, a costly part or system of the vehicle might be unnecessarily replaced. Only tasks designated as "High" on criticality would be considered.

(5) The problem should be one that often occurs in the field, that is, a problem of high or medium frequency. Frequency was defined as:

Low: No more than once or twice a year in a battalion-size unit.

High: More than six times a year in a battalion-size unit.

(6) High-density vehicles or vehicle systems would be utilized in forming problems.

These criteria were carefully considered in preparing each item, but not all of them were maximally met in each problem. The various criteria had to be weighed by the item writers in order to produce a representative sample of items which could be used to test as many people as possible within a given period of time and within the limits imposed by availability of equipment and personnel.

A total of 33 items—17 troubleshooting, 12 corrective action, and four preventive maintenance— were completed and sent to the Automotive Department of the U.S. Army Armor School to be reviewed for currency and technical accuracy.

TEST ITEM FORMAT

In order to standardize test administration and scoring procedures, each item was composed of two parts. The first part (Appendix B) presented the content. It began with a statement of the symptom (for troubleshooting problems) or the action to be performed (for corrective action and preventive maintenance problems); this section was read by the tester to the subject. The essential procedures or approved steps for completing the task were then listed, with each step keyed as either essential (E) or optional (O), according to the judgment of the technical experts. Also included were spaces for writing in any parts mistakenly identified for replacement, and for recording the subject's previous experience with similar tasks.

The second part (Appendix C) was a performance checklist common to all test items. It was headed by a block of four passing and four failing categories. If a subject correctly reported the malfunction or correctly performed the required action, he was

scored in the pass section, and his degree of pass was indicated by one of four descriptive statements. The same type of scoring was used if he failed the problem. These descriptive statements are:

Pass:

Used good procedures; knew what he was doing
Had a pretty good idea, but some guess work
Knew very little; probably just a good guess
Knew very little; but used publication accurately

Fail:

Didn't know enough to get started
Started but gave up quickly
Some knowledge of what to do but much guess work also
Had fairly good grasp of the problem but failed

The use of this scoring provided additional information on the quality of performance which could be related to the Army's training system, in terms of identifying areas for training emphasis.

All of the test items were scored on this two-part form. In this way, testing and scoring were made fairly uniform.

TEST ADMINISTRATOR TRAINING

Ten experienced mechanics (E5s and E6s) were trained to administer the tests. The training period for the testers was three and one-half days, during which time vehicles were placed in the working bays and problems were set into them. The problems were then tried out by the mechanics so they could familiarize themselves with test administration procedures and typical problems that might be encountered.

TEST ADMINISTRATION

Before a subject was tested, he was asked to fill out a questionnaire (shown in Appendix D) that required information in the following areas: (a) personnel data, (b) organizational maintenance experience on track and wheel vehicles, (c) experience on various vehicle systems, (d) current job assignment, (e) type and amount of training, and (f) amount of supervision received on the job.

The subjects then received a thorough briefing on the nature of the tests and test procedures, and were encouraged to do their best on each problem. It was emphasized that they were *not* being personally evaluated for the record, but that their scores would be used solely for research purposes. They were further encouraged to view the tests as a novel learning experience.

During the first day and a half of testing, each man was given the 17 troubleshooting problems (20 minutes per station). During the next day and a half, they were given the 12 corrective action problems (20 minutes per station for eight stations, and 30 minutes per station for four stations) and during the last day, the four preventive maintenance problems (15 minutes per station).

Each day, the individual was given a schedule of his route from station to station and was told which station to report to first. One vehicle was located in each of five bays

(or work areas) of two large motor-pool buildings.[2] At each station the pretrained tester read the specific directions for the problem to the subject. (The directions were printed on each test sheet.) The subject was further instructed to proceed as he normally would on the job, using the test equipment, tools, and publications located at each test station. Testers were instructed to avoid conversation with the men being examined and to give them no help beyond repeating instructions. However, the tester did act as a helper by cranking the engine, holding a light, turning switches, and so forth, when requested.

Performance was observed by the tester and recorded on the checklist. At the end of the time period (20 or 30 minutes), an air horn was blown and the men moved to another station, in this way completing the prescribed number of tests. After each exercise, the tester completed the summary score sheet (shown in Appendix C) which contained pass-fail categories of performance and some 20 statements describing the errors of performance. This same overall testing procedure was used for all four groups.

The test stations were situated in such a way that a man could not easily observe the activity at another test station. In addition, men in the four different test groups were selected, whenever possible, from different organizational maintenance units at Fort Knox, so that communication between groups was minimized.

It is believed that the actual job tasks were meaningfully duplicated except in two cases where it was necessary to remove the power plants from the vehicles and hook them up to the power source with "slave" cables or "ground-hop" kits.

TEST SCORES AND PERSONNEL DATA

Each exercise was scored on a *pass* or *fail* basis. A man's total score was simply the number of exercises he completed correctly out of the 33 on which he was tested.

The supplementary data used in the analysis include: (a) General Technical (GT) and Motor Maintenance (MM) aptitude scores;[3] (b) number of years of maintenance experience; (c) type and number of maintenance schools completed; (d) current job assignment; (e) experience on different types of vehicles; and (f) supervision given on the job.

RESULTS

TEST CHARACTERISTICS

Item Analysis

While a preliminary item analysis was performed, it should be realized that item analysis for this criterion measure is not the same as for classical psychometric applications, because the content of a job sample criterion is established by analysis of the job. In other applications of item analysis, for classical psychometric uses, the main purpose is establishing a homogeneous pool of items. Homogeneity in the pool of items is, in principle, inapplicable for work sample tests such as this criterion measure whose content is job sampling or measuring components of a job which may or may not form a

[2] The other vehicles were parked in a third motor-pool building and used as a back-up for vehicles which may have become defective during testing.

[3] Army Aptitude Area scores based on combinations of scores on the Army Classification Battery (ACB).

homogeneous pool of items. Consequently, the item analysis used in this study provides data on the nature of the items rather than a direct and specific basis for eliminating items from a final form of the test.[4]

The item analysis was concerned with two statistical aspects: first, the *difficulty level* of the item, that is, the proportion of people who get the item correct; second, the *discrimination index* of the item, that is, the degree to which the item differentiates subjects who are high from those who are low, in terms of a standard. The standard, in this case, was performance on the complete pool of items.

The range and mean values for the difficulty level (P) of the various groups of items are shown in Table 2, and a more complete table of all item P values is presented in Appendix E. These data indicate that the troubleshooting items tend to be the most difficult, and the corrective action items the least difficult.

Table 2

Range and Mean Difficulty Level (P) Values for Various Groups of Test Items

Test Items	Difficulty Level (P)	
	Range	Mean
Troubleshooting	.24- .89	.48
Corrective Action	.32-1.00[a]	.77
Preventive Maintenance	.37- .81	.63
Total Test	.24-1.00[b]	.60

[a]If the one item with a P value of 1.00 were eliminated, the range would be .32-.89.

[b]If the one item with a P value of 1.00 were eliminated, the range would be .24-.89.

The second item analysis characteristic is the degree to which the item differentiates subjects who are high from those who are low on the complete pool of items. This index gives an indication of the internal consistency of the test. The range and mean discrimination indices of the items are given in Table 3, and a more complete table of all item discrimination indices is presented in Appendix E. Table 3 and Appendix E include discrimination indices both in relation to total test score and in relation to the relevant subtest (e.g., troubleshooting) score. These data indicate that the corrective action items tend to show the greatest internal consistency, and the troubleshooting items the least consistency.

Table 3

Range and Mean of the Discrimination Indices[a] Between Test Items and Various Test Scores

Test Scores	Test Items							
	Troubleshooting		Corrective Action		Preventive Maintenance		All Test Items	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Subtest	–.10-.75	.30	.19-.88	.59	.19-.64	.36	–	–
Total Test	.10-.83	.37	.12-.96	.65	.36-.53	.42	.10-.96	.48

[a]The Biserial Coefficient of Correlation has been corrected for spurious item–total overlap.

The lower item difficulty and discrimination indices for the troubleshooting items are most probably due to the greater heterogeneity in item content, and also in item difficulty, as compared to the same properties in the corrective action and preventive maintenance items.

Therefore, the results of the item analysis, as shown in Tables 2 and 3, indicate that: (a) The average difficulty level of the items in the test is acceptable, as is the range

[4]These data would be useful as a means of discovering and eliminating unsatisfactory items rather than as a means of selecting a small fraction of items that can be identified as "the best."

of the difficulty indices (for efficient differential measurement, a test must have a relatively wide range of item difficulties with an average difficulty level of about .50). (b) The items are useful in distinguishing between those who score high and those who score low on the total test.

Test Reliability

It was necessary to establish the level of reliability of the present criterion, because a necessary (but not sufficient) condition for correlation between a criterion measure, such as the present work sample, and the theoretically perfect ultimate criterion of job success is that the criterion measure have some reliability (i.e., consistency with which the measuring instrument would produce the same measurement in testing and retesting an individual).

To extract an estimate of reliability from a single administration of the test, it was decided to divide the total test into two half-length tests and correlate the scores on the halves. The test was therefore divided so that the items in each half would be as comparable as possible on the following factors: (a) problem type (troubleshooting, corrective action, preventive maintenance); (b) vehicle type (wheel or track); (c) vehicle system (engine, cooling, electrical, etc.); and (d) special tools and equipment required to solve the problem.

Of the 12 items in the corrective action part of the test, one was eliminated because, after repeated work on the vehicle, the part to be repaired became clearly identifiable and therefore cued the subject to the correct action. Of the 11 items remaining, one had to be eliminated in order to make an equal distribution of items into two separate half tests. It was decided to eliminate the only item that showed an r_b greater than 1.00 because of unusual distribution features.

Table 4

Average Difficulty Level (P) and Mean Scores for Half Tests

Test Elements	Test Characteristics		
	Average P	Items Correct	
		Mean	Standard Deviation
Troubleshooting Subtest			
Half-Test 1	.46	3.6	1.5
Half-Test 2	.46	3.6	1.7
Corrective Action Subtest			
Half-Test 1	.73	3.6	1.7
Half-Test 2	.74	3.7	1.4
Preventive Maintenance Subtest			
Half-Test 1	.67	1.0	0.7
Half-Test 2	.59	1.5	0.8
Total Test			
Half-Test 1	.57	8.6	3.1
Half-Test 2	.57	8.6	2.9

Of the 17 items in the troubleshooting part of the test, one had to be eliminated in order to make an equal distribution of the items into two separate half tests. It was decided to eliminate the item that had the lowest r_b and at the same time the most extreme P value.

After items were discarded and the remainder divided, each half test consisted of 15 items. The two half tests were then analyzed; the average difficulty level (P value) and mean items correct for each half test are given in Table 4.

The data indicate that the two half tests are not only theoretically equivalent but also statistically equivalent—that is, tests of significance of differences showed no significant difference between the means and standard deviations.

The scores on the two half tests were then correlated, yielding values (corrected for double-length) between the troubleshooting, corrective action, and preventive maintenance tests, respectively, of .71, .78 and .63. The correlation between the total score on both half tests was .82 (corrected for double-length). All these correlation coefficients indicate, both statistically and practically, a significantly high degree of test reliability.

These results therefore indicate that the work sample criterion appears to satisfy the requirement for "some degree of reliability."

PERFORMANCE OF ORGANIZATIONAL MAINTENANCE BY GENERAL VEHICLE REPAIRMEN

A secondary objective of the study was to gather information on the current performance level and quality of performance of automotive mechanics. This information is presented in the following sections.

Test Performance. The percent of total items passed by the group, by MOS skill level, is presented in Table 5.

Table 5

Mean Test Performance by MOS and Total Group

MOS	Number of Subjects	Mean Percent of Total Items Passed
63C30	15	60
63C40	23	61
Total	38	60

There is no practical difference in performance between the higher and lower skill level mechanic as evidenced by the fact that 63C30 mechanics passed 60% of the items, and the 63C40 mechanics 61%. According to the existing MOS structure and philosophy, one might expect this result; the basic difference between an MOS 63C30 and an MOS 63C40 mechanic is in supervisory skills, which would not make a difference in the performance of hands-on-equipment test problems.

Maintenance Experience. When test performance was examined as a function of automotive maintenance experience, the data presented in Table 6 indicate only a moderate relationship between a man's length of experience on the job and his level of performance in the areas of troubleshooting and corrective action tasks. This relationship does not seem to hold for preventive maintenance tasks; however, the nature of such tasks would not require that a man have a great deal of experience to perform them adequately, so the lack of correlation is not surprising.

Thus, the data indicate that on the basis of a broad correlational analysis, there is a moderate relationship between length of experience and performance on the test.

Maintenance Training. Test performance was studied as a function of type of training (see Table 7). Mechanics who had some kind of formal training performed slightly better than mechanics who had only on-the-job training. On the basis of these data, there would seem to be little, if any, difference in performance among mechanics who have different types of formal training.

Table 6

Correlation Between Work Sample Test Scores and Length of Experience (N=38)

Test Scores	Correlation[a] With Experience	p
Troubleshooting	.41	<.05
Corrective Action	.39	<.05
Preventive Maintenance	.04	*NS*
Total Test	.38	<.05

[a]Pearson Product Moment Correlations were computed.

Job Assignment. The 34 subjects[5] were divided by current job assignment into two groups—maintenance job in primary MOS, and supervisory job in primary MOS. For the 15 men who were at that time assigned to a maintenance job in their primary MOS, the average performance score was 64%. For the 19 men assigned to a supervisory job in their primary MOS, the average performance score was 61%. Thus, there was little difference in the level of performance between people in different job assignments.

Aptitude Area Scores. The means of the subjects' General Technical (GT) and Motor Maintenance (MM) aptitude scores were 97.9 and 110.4 respectively. Pearson Product Moment correlations were calculated between the aptitude scores and the performance test scores. The r between GT and performance test scores was .35 and the r between MM and work sample scores was .38. These correlations show a moderate degree of relationship between the aptitude variables and performance test proficiency; they are statistically significant (p<.05).

Table 7

Mean Test Performance by Various Types of Training

Type of Training and School	Mean Percent of Total Items Passed
Service School (Fort Knox, Fort Sill, Fort Benning)	66
Other School (USAREUR, Aberdeen Training Center)	63
Service and Other School (Combination of above schools)	55
On-the-Job-Training	49

The results of significance of difference tests between the GT and MM mean scores and for subjects who scored in the upper or in the lower third of the total group are provided in Table 8.

The results indicate that while the amount of difference was large enough to produce a significant difference between the high and low performance groups in mean GT scores, there was not sufficient difference to demonstrate difference in MM scores between the high and low performance groups.

Performance Characteristics. Performance characteristics of the upper and lower thirds of the group as described in the pass-fail categories are given in Table 9.

As the data indicate, a high percentage of those who failed were described by the statement: "Didn't know enough to get started." In contrast, to a high percentage of those who passed the statement, "Used good procedures, knew what he was doing," was applicable. It should be noted that among those people who failed and were in the upper one-third of the group, the greatest percentage still used "fairly good procedures."

[5]Of the total 38 subjects tested, four were holding clerical jobs in their primary MOS and were therefore eliminated from this analysis.

Table 8

Test of Differences Between the GT and MM Means for Upper and Lower Performance Groups
(*N*=26)

Aptitude Test	Score Group	Mean	Standard Deviation	*df*	*t*	*p*
GT	Upper Third	100.1	2.6	24	2.12	<.05
	Lower Third	89.6	4.2			
MM	Upper Third	114.4	3.7	24	1.44	*NS*
	Lower Third	105.6	4.8			

Use of Required Procedures. The degree to which "required" steps were followed in completing each test item is presented in Table 10. It would be expected that those who scored higher on the test also completed the "required" steps, and the data show this trend; however, the trend is not as strong as might be expected. If these steps, taught in the schools and listed in the technical publications, are truly "required," one would expect successful performance to be absolutely dependent on the completion of all the "required" steps. However, the data indicate that frequently men pass test items and perform less than 100% of the "required" procedures. Therefore, it may be concluded that these required steps are helpful but not essential to successful performance.

Table 9

Test Item Performance in the Descriptive Pass-Fail Categories

Category	Total Test Performance (percent)	
	Upper Third	Lower Third
Pass		
Good Procedures	63	23
Some Guesswork	10	4
All Guesswork	0	9
Accurately Used Publications	4	7
Fail		
Fairly Good Procedures	13	3
Much Guesswork	5	8
Gave up Quickly	1	2
Didn't Get Started	4	43

Use of Test Equipment. The use of test equipment by people in the upper and lower performance groups is shown in Table 11. Not all problems required the use of test

Table 10

Percent of Test Items in Which "Required" Procedures Were Used by High and Low Performance Groups

Total Test Performance	"Required" Procedures Followed			
	More Than One-Half	One-Half	Less Than One-Half	None
Upper Third	54	4	14	28
Lower Third	34	3	11	52

Table 11

Percent of Test Items in Categories of Test Equipment Usage for High and Low Performance Groups

Total Test Performance	Use of Test Equipment			
	Used Properly	Did Not Use	Could Not Operate	Did Not Know Procedures
Upper Third	54	41	1	3
Lower Third	24	70	0	5

equipment, and those that did not are combined, in the first category of the table, with the occurrence of proper usage when required.

As expected, the people in the high performance group used the test equipment far more often than those in the low performance group. Failure to use the test equipment may have been due either to not knowing *how* to use it or not knowing *when* to use it. The low performing group was primarily characterized by the statement, "did not use the equipment."

Use of Publications. The difference with which technical publications were used by the people who scored in the upper and lower thirds of the total group is shown in Table 12.

Table 12

Percent of Test Items in Categories of Publications Usage for High and Low Performance Groups

Total Test Performance	Use of Publications			
	Used Properly	Did Not Use	Could Not Find Reference	Could Not Understand Reference
Upper Third	53	21	14	12
Lower Third	18	57	9	15

Failure to use publications and their misuse occurred often in both groups, but far more often in the low performance group. Even though the high performance group used the manuals correctly on 53% of the items, there was still a surprisingly high 47% of the items in which the manuals were not used or were used incorrectly.

By contrast, the low performance group used the manuals correctly on only 18% of the items; on the rest of the items, the manuals either were not used or were used incorrectly.

DISCUSS[illegible]ND OBSERVATIONS

The results of this study indicate that the work sample criterion appears to be, in fact, a reliable (r=.82) and relevant measure of a mechanic's proficiency level. This work sample may consequently be used as a standard for the evaluation of other measurement techniques.

Concerning the performance of organizational maintenance by general vehicle repairmen, in many respects the results of the current testing program tend to corroborate the findings of similar studies on organizational mechanics. In 1966,[6] the performance level of organizational mechanics was found to be approximately 68%; the current study found their performance level to be approximately 60%. Lack of use and unfamiliarity with technical publications, in addition to lack of skill in the use of special tools and equipment, continue to be significant correlates of low proficiency. There is also a moderate correlation between experience and job performance. When mechanics were questioned concerning OJT, they described it as a "pick up whatever you can" situation, which would seem to indicate that OJT is not an integrated part of maintenance shop activity.

The results also indicate that while mechanics trained in service schools perform slightly better, there is only a small difference in their performance and that of mechanics who are trained in other ways.

Also, there is only a small difference in performance between mechanics who have supervisory assignments and those who have automotive mechanic assignments. This is to be expected since a mechanic who is in a supervisory assignment is also qualified and responsible for all automotive mechanic tasks.

Finally, it is felt that the problem of developing and maintaining a highly proficient automotive mechanic is extremely complex and difficult. There are no simple answers as to exactly what makes a "proficient" mechanic. The problem as a whole is confounded with problems of personnel selection and classification, assignment procedures, the training system, and the Enlisted Evaluation System.

[6] In a study by William C. Osborn, dealing with the performance proficiency of automotive and turret mechanics in diagnosing and repairing malfunctions.

LITERATURE CITED
AND
APPENDICES

LITERATURE CITED

1. Department of the Army. *Organization and Functions, Department of the Army*, AR 10-5, May 1969, para 2-25(1).

2. Glaser, Robert, and Klaus, David J. "Proficiency Measurement: Assessing Human Performance," *Psychological Principles in System Development*, R.M. Gagne (ed.), Holt, Rinehart and Winston, Inc., New York, 1962.

3. Yellen, Ted M.I. *Preliminary Validity Report of the MOS Evaluation Test for Track Vehicle Mechanic, MOS Code 632.2 (63C20)*, Research Study 49, U.S. Army Enlisted Evaluation Center, Fort Benjamin Harrison, Inc. 1966, p. 25.

4. Urry, V.W., Shirkey, E.C., and Nicewander, W.A. *Preliminary Validity Report of the MOS Evaluation Test for Personnel Specialist, MOS Code 716.1*, Research Study 21, U.S. Army Enlisted Evaluation Center, Fort Benjamin Harrison, Inc. 1965, p. 23.

5. Engel, John D. *A Revised Job Requirements Inventory for General Vehicle Repairman, MOS 63C*, HumRRO Research By-Product, December 1968.

Appendix A

PROFICIENCY TEST FOR GENERAL VEHICLE REPAIRMAN: LIST OF EXERCISES

Troubleshooting Subtest

	Problem	Vehicle
1	Defective cooling fan clutch	M60
2	Defective wire from engine wiring junction block to engine low oil pressure light	M60
3	Defective neutral switch	M113
4	Master relay will not close	M108
5	Defective fuel pump	M151A1
6	Defective hull wiring harness	M108
7	Defective wire from engine wiring junction block to engine transmission oil switch	M60
8	Defective spade cylinder	M110
9	Defective clutch assembly	M35A1
10	Defective distributor capacitor	M151A1
11	Defective starter solenoid	M60
12	Defective generator regulator	M60
13	Defective starter solenoid circuit	M108
14	Defective generator to regulator wiring harness	M54A2
15	Defective instrument panel wiring harness	M60
16	Defective power plant wiring harness	M110
17	Defective generator	M151A1

Corrective Action Subtest

1	Adjust reverse and low brake bands	M60
2	Replace universal joint	M151A1
3	Adjust valve clearance	M151A1
4	Adjust reverse shift linkage	M35A1
5	Replace wheel cylinder	M151A1
6	Carburetor adjustment	M151A1
7	Repair dimmer switch wiring harness	M113
8	Replace steering gear relay lever	M54A2
9	Adjust brake bands	M60
10	Adjust clutch linkage	M151A1
11	Toe in adjustment	M151A1
12	Adjust front wheel bearing	M151A1

Preventive Maintenance Subtest

	Problem	Vehicle
1	Check Modification Work Order	M110
2	Check Modification Work Order	M110
3	Check Modification Work Order	M110
4	Check Modification Work Order	M88

Appendix B

PROFICIENCY TEST FOR GENERAL VEHICLE REPAIRMAN: SAMPLE EXERCISE

Electrical System M54A2 (M35A1)—Five-Ton Truck

MALFUNCTION: Defective Generator to Regulator Wiring Harness (open in wire no. 2).

SYMPTOM: Battery/generator indicator shows no charge.

SPECIAL TOOLS AND EQUIPMENT: L.V.C.T., test adaptor set, jumper wire.

DIRECTIONS TO THE TESTER:

Tell the subject: "The battery generator indicator shows no charge. Find the trouble and report it to me."

SUBJECT'S PERFORMANCE:

(1) Started and operated the engine at 1,000-1,200 rpm. E _____

(2) Connected voltmeter from positive battery terminal to ground. (No increase in voltage.) _____

(3) Disconnected battery connector at voltage regulator and checked output from regulator. (Voltmeter from regulator terminal to ground) (no output) _____

(4) Disconnected generator to regulator cable at voltage regulator, connected jumper from terminal A to terminal B (cable side) and voltmeter from jumper to ground. (engine operating) (no voltage) E _____

(5) Disconnected generator to regulator cable at generator, connected jumper from terminal A to terminal B of the generator connector and voltmeter from jumper to ground. (voltage now indicated) E _____

(6) Reported defective generator to regulator cable. E _____

NOTE: Preferred method is using adaptors and field rheostat portion of L.V.C.T.

(7) All parts correctly re-installed, if appropriate. E _____

(8) Parts erroneously condemned—write in.

_____

_____

Did subject utilize field rheostat? Yes _____ No _____

Did subject encounter any problems with L.V.C.T.? (explain) Yes _____ No _____

Appendix C

PROFICIENCY TEST FOR GENERAL VEHICLE REPAIRMAN: SAMPLE SUMMARY PERFORMANCE CHECKLIST

SUMMARY PERFORMANCE CHECKLIST

SUBJECT _____ TESTER _____ ITEM NO. _____

I. SUBJECT DETECTED MALFUNCTION OR COMPLETED OPERATION PROPERLY . . . . . _____

CHECK ONE
- 0. Used good procedures; knew what he was doing . . . . . _____
- 1. Had a pretty good idea, but some guesswork . . . . . _____
- 2. Knew very little; probably just a good guess . . . . . _____
- 3. Knew very little; but used publication accurately . . . . . _____

II. SUBJECT FAILED . . . . . _____

CHECK ONE
- 0. Didn't know enough to get started . . . . . _____
- 1. Started but gave up very quickly . . . . . _____
- 2. Some knowledge of what to do but much guesswork also . . . . . _____
- 3. Had fairly good grasp of the problem but failed . . . . . _____

CHECK ANY STATEMENTS BELOW THAT APPLY TO OR EXPLAIN FAILURE OR POOR PERFORMANCE OF SUBJECT

Procedures
- 00. Proceeding O.K. but too slow . . . . . _____
- 01. Didn't know essential operation or step no. (___) . . . . . _____
- 02. Didn't make essential "operational" checks such as revving up engine, turning switches, etc. . . . . _____
- 03. Incorrectly reinstalled parts . . . . . _____

Location of Malfunction
- 04. Unable to pick out correct system to work on . . . . . _____
- 05. Got right system but wrong components . . . . . _____
- 06. Got right system and right components but couldn't test them . . . . . _____

Use of Special Tools and Test Equipment
- 07. Failed to use special equipment . . . . . _____
- 08. Tried to use it but didn't know how to hook it up . . . . . _____
- 09. Tried to use it but didn't know where to hook it up . . . . . _____
- 10. Knew how and where but didn't know procedures . . . . . _____
- 11. Used it properly but couldn't read results of checks . . . . . _____
- 12. Used wrong equipment for test or check . . . . . _____
- 13. Put too much ( ) or too little ( ) stress or load on equipment (Check one.) . . . . . _____

Use of Publications
- 14. Didn't use publications . . . . . _____
- 15. Selected wrong publication . . . . . _____
- 16. Selected right publication but couldn't find right section . . . . . _____
- 17. Selected right publication and section but didn't understand instructions . . . . . _____
- 18. didn't understand wiring circuit diagram . . . . . _____
- 19. didn't understand troubleshooting diagram . . . . . _____
- 20. didn't understand technical specifications . . . . . _____

III. HOW WAS THE SUBJECT TRAINED FOR THIS SPECIFIC TEST PROBLEM?
- 0. Has never had any training—entirely self-taught . . . . . _____
- 1. Has had a basic maintenance course . . . . . _____
- 2. Has had one or more classes on this problem, lasting between ½ day and one week. Ordnance___, Tech. Rep.___, Battalion (or higher) NCO's___. . . . . _____
- 3. Was taught on job by a supervisory NCO such as the Motor Sergeant . . . . . _____
- 4. Was taught on job by another mechanic . . . . . _____
- 5. Other training (write in) . . . . . _____

(Use reverse side of this page for remarks.)

Appendix D

PROFICIENCY TEST FOR GENERAL VEHICLE REPAIRMAN: SAMPLE ORGANIZATIONAL MAINTENANCE PERSONNEL INVENTORY

1. _____ _____ _____
   Last name (PRINT) First name Initial

2. Circle your rank. E5 E6 E7 E8 E9

3. Serial number. _____ 4. Primary MOS. _____

5. Print in the name of the organization you are now working in:
   _____

6. What is your parent organization, if different from number 5?
   _____

7. Write in the number of years and months of military experience you have had as an automotive mechanic.
   _____ years _____ months

8. Write in the number of years and months of track vehicle organizational maintenance experience you have had.
   _____ years _____ months

9. Write in the number of years and months of wheel vehicle organizational maintenance experience you have had:
   _____ years _____ months

10. Make an X in the box corresponding to the type of vehicle and vehicle system on which you have worked.

	Electrical	Transmission	Winch, Power Take Off and Hoist	Clutch	Cooling	Engine	Air-Fuel	Transfer	Differential-Front Drive
Light Trucks									
Medium Trucks									
Heavy Trucks									
Personnel Carriers									
Light Tanks									
Medium Tanks									
Tank Recovery Vehicles									

11. Check the course or courses which you have had and indicate specifically where the course was taken. (for example, TVR | Yes: X | No: ____ | Where: Armor school, Ft. Knox)

	Yes	No	Where
Mechanic's Helper	____	____	____
WVM	____	____	____
TVM	____	____	____
GVR	____	____	____
TVR	____	____	____
Advanced School Course	____	____	____

12. If you took an advanced course, please complete the following form.

	Place	Course length in weeks	Subject taught
1.	____	____	____
2.	____	____	____
3.	____	____	____
4.	____	____	____
5.	____	____	____

13. Briefly describe the kind of work required in your present assignment.

Please PRINT

Appendix E

DIFFICULTY LEVEL (P) AND DISCRIMINATION INDEX (r_b)[a] OF TEST ITEMS FOR THE TOTAL TEST AND SUBTESTS

Exercise Number	Troubleshooting			Corrective Action			Preventive Maintenance		
	P	r_b for Subtest	r_b for Total Test	P	r_b for Subtest	r_b for Total Test	P	r_b for Subtest	r_b for Total Test
1	.29	.17	.19	.84	.82	.90	.65	.25	.38
2	.34	.10	.19	.81	.68	.66	.37	.29	.40
3	.53	.47	.49	.86	1.10	1.01	.81	.19	.36
4	.50	.22	.40	.67	.42	.47	.68	.64	.53
5	.71	.75	.83	.88	.60	.43			
6	.79	.27	.36	.60	.19	.12			
7	.37	.11	.30	.67	.35	.57			
8	.37	.22	.34	1.00	0	0			
9	.87	.11	.21	.83	.77	.96			
10	.55	—.10	.10	.83	.88	.71			
11	.27	.50	.50	.32	.27	.30			
12	.34	.48	.42	.81	.44	.57			
13	.79	.51	.64						
14	.47	.12	.15						
15	.24	.20	.24						
16	.32	.40	.33						
17	.45	.23	.20						

[a]Biserial Coefficient of Correlation, corrected for spurious item-total test overlap.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Human Resources Research Organization (HumRRO)
300 North Washington Street
Alexandria, Virginia 22314

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
DEVELOPMENT OF A WORK SAMPLE CRITERION FOR GENERAL VEHICLE MECHANIC

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Technical Report

5. AUTHOR(S) *(First name, middle initial, last name)*
John D. Engel

6. REPORT DATE
July 1970

7a. TOTAL NO. OF PAGES
32

7b. NO. OF REFS
5

8a. CONTRACT OR GRANT NO.
DAHC 19-70-C-0012

b. PROJECT NO.
2Q062107A712

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
Technical Report 70-11

9b. OTHER REPORT NO.(S) *(Any other numbers that may be assigned this report)*

10. DISTRIBUTION STATEMENT
This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES
Work Unit JOBTEST, Proficiency Measurement Techniques

12. SPONSORING MILITARY ACTIVITY
Office, Chief of Research and Development
Department of the Army
Washington, D.C. 20310

13. ABSTRACT

A work sample criterion test was developed for General Vehicle Repairman, MOS 63C30 and 63C40. Test items covered three task categories: troubleshooting, corrective action, and preventive maintenance. Thirty-eight organizational mechanics were tested at Fort Knox, Kentucky. Data were also collected on the quality of performance, for example, use of good procedures, use of test equipment, and so forth. The study indicated that (a) the test appears to have a high degree of reliability (r=.82), (b) on the average, 60% of the test exercises were successfully completed by the 38 mechanics, (c) there was a moderate relationship between performance and length of experience, and (d) there were indications of lack of use and unfamiliarity with technical publications, and also a lack of skill in the use of special tools and equipment.

DD FORM 1 NOV 65 1473

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Automotive Mechanic						
Criterion Development						
Human Performance						
Maintenance						
Test Development						
Work Sample						

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1 CG US ARMY AD COMD ENT AFB ATTN ADGCB
6 CG 1ST ARMY ATTN OCSOT FT MEADE MD
1 CG 3RD ARMY ATTN OCSOT FT MCPHERSON
2 CG 4TH ARMY ATTN AKADC-BI(UT) FT SAM HOUSTON
1 CG FOURTH ARMY FT SAM HOUSTON ATTN G3
2 CG FIFTH ARMY FT SHERIDAN ATTN ALFGC TNG
1 CG EUSA ATTN AG-AC APO 96301 SAN FRAN
2 CG EUSA ATTN G-3 APO 96301 SAN FRAN
1 DIR HEL APG MD
1 CG USA CDC EXPERIMENTATION COMD FT ORD
2 ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1 TECH LIB ARMY NATICK LABS NATICK MASS
2 INST OF LAND CBT ATTN TECH LIB FT BELVOIR VA
1 CO USA CDC CBR AGCY ALA
1 REDSTONE SCIENTIFIC INFC CTR US ARMY MSL COMD ATTN CHF DOC SEC ALA
1 CO USAPA MBLTY DET TOBYHANNA ARMY DEPOT
1 CO FT HUACHUCA SPT COMD USA ATTN TECH REF LIB
12 CO 1ST AIR DEF GUIDED MSL BRGD TNG FT BLISS
2 CG US ARMY CDC EXPERIMENTATION COMD FT ORD
1 SIXTH USA LIB DEPOT BLDG M 13 14 PRES OF SAN FRAN
1 PLANS OFFICER PSYCH HDQTRES USACDCEC FORT ORD
5 CG FT ORD ATTN G3 TNG DIV
1 DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR
2 DIR WHAIR WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1 CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 TECH LIB BOX 22 USACDC EXPERIMENTATION COMD FT ORD
1 HUMAN FACTORS TEST DIV (ADHZ) USAF HOSP EGLIN AFB
1 CO USA MOBILITY EQUIP R&D CTR ATTN TECH DOC CTR FT. BELVOIR
1 CO FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
3 6TH RGN USARADCOM FT BAKER
1 4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
1 DIR ARMY BD FOR AVN ACCIDENT RES FT RUCKER
2 CO PICATINNY ARSNL DOVER N J ATTN SUMPA VCI
1 DEF SUPPLY AGY CAMERON STATION ATTN LIB
2 CO USA CDC AG AGCY FT BENJ HARRISON IND
1 REF M MS IS NASA ALA
1 CBT OPRS RES GP USACDC SP OPRS ANALYST HUMAN FACTORS ALEX VA
1 CO ARMY CDC INF AGY FT BENNING
1 CO ARMY CDC ARMOR AGY FT KNOX
1 EVAL DIV OAO ARMY SIG CTR & SCH FT MONMOUTH
1 CO US ARMY CDC AVN AGCY FT RUCKER
15 CG USA TNG CTR AD ATTN ACOFS G3 FT BLISS
1 CG USA TNG CTR ARMOR ATTN ACOFS G3 FT KNOX
12 CO USA TNG CTR (FA) ATTN ACOFS G3 FT SILL
1 CG USA TNG CTR & FT LEONARD WOOD ATTN ACOFS G3
1 CG USA TNG CTR INF ATTN ACOFS G3 FT BENNING
1 CG USA TNG CTR INF ATTN ACOFS G3 FT DIX
1 CG USA TNG CTR ATTN ACOFS G3 FT JACKSON
1 CG USA TNG CTR INF ATTN ACOFS G3 FT LEWIS
1 CG USA TNG CTR INF & FT ORD ATTN ACOFS G3
30 CG USA TNG CTR INF ATTN ACOFS G3 FT POLK
5 CO USA MED TNG CTR ATTN DIR OF TNG FT SAM HOUSTON
1 CG USA TNG CTR INF ATTN ACOFS G3 FT BRAGG
1 CG USA TNG CTR INF ATTN ACOFS G3 FT CAMPBELL
2 CIVLN PERS OFCR US ARMY SPT CTR ST LOUIS ATTN EMPLOYEE DEVEL OFCR
3 LIB ARMY WAR COLL CARLISLE BKS
1 COMDT COMD & GEN STAFF CO FT LEAVENWORTH ATTN ARCHIVES
1 DIR OF MILIT PSYCHOL & LDRSHP US MILIT ACAD WEST POINT
1 US MILIT ACAD WEST POINT ATTN LIB
1 COMDT ARMY AVN SCH ATTN DIR OF INSTR FT RUCKER
2 COMDT ARMY SECUR AGY TNG CTR & SCH FT DEVENS ATTN LIB
1 MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON ATTN STENSON LIB
10 DIR OF INSTR ARMOR SCH FT KNOX
1 COMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1 COMDT USA CHAPLAIN SCH ATTN DOI FT HAMILTON
1 COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1 COMDT USA FIN SCH ATTN CHF DOC DEV LIT PLN DIV IND
1 USA FINANCE SCH FT BENJ HARRISON ATTN EDUC ADV
4 COMDT ARMY ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ADV
1 EDUC ADV USAIS ATTN AJIIS-H FT BENNING
1 DIR OF INSTR USAIS ATTN AJIIS-D-EPRD FT BENNING
1 HQ US ARMY ADJ GEN SCH FT BENJ HARRISON ATT COMDT
1 LIB ARMY QM SCH FT LEE
1 COMDT ARMY QM SCH FT LEE ATTN EDUC ADV
1 COMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1 CO USA SEC AGY TNG CTR & SCH ATTN IATEV NSCH ADV FT DEVENS
1 COMDT ARMY MILIT POLICE SCH FT GORDON ATTN DIR OF INSTR
2 COMDT US ARMY SOUTHEASTERN SIG SCH ATTN: EDUC ADVISOR FT GORDON
1 COMDT USA AD SCH FT BLISS
1 CO USA ORD CTR & SCH OFC OF OPS ATTN AMXN-O APG MD
5 ASST COMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LIB
4 CG USA FLD ARTY CTR ATTN AVN OPER FT SILL
1 COMDT ARMY DEF INTEL SCH ATTN SI&AS DEPT
1 COMDT ARMED FORCES STAFF COLL NORFOLK
1 COMDT USA SIG CTR & SCH ATTN DOI FT MONMOUTH
1 COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1 DPTY COMDT USA AVN SCH ELEMENT GA
1 USA AVN SCH ELEMENT CFC OF DIR OF INSTR ATTN EDUC ADV GA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 COMDT USA ENGR SCH ATTN EDUC ADV FT BELVOIR
2 COMDT US ARMY SCH EUROPE ATTN REF LIB APO 09172 NY
1 CHF POLICY & TNG LIT DIV ARMY ARMOR SCH FT KNOX
1 COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
1 COMDT ARMY PRIMY HEL SCH FT WOLTERS
1 DIR OF INSTR US MIL ACAC WEST POINT NY
1 DIR OF MILIT INSTR US MILIT ACAD WEST POINT
1 USA INST FOR MIL ASSIST ATTN LIB FT BRAGG
4 USA INST FOR MIL ASSIST ATTN COUNTERINSURGENCY DEPT FT BRAGG
1 ARMY SIG CTR & SCH FT MONMOUTH ATTN TNG LIT DIV DAC
2 COMDT USA MSL & MUN CTR & SCH ATTN CHF OFC OF OPS PERSONNEL ASSTS
2 COMDT US WAC SCH US WAC CTR ATTN AJWCT FT MCCLELLAN

2 HQ ABERDEEN PG ATTN TECH LIB
1 COMDT USA INTELL SCH ATTN DIR OF ACADEMIC OPS FT HOLABIRD
1 COMDT USA INTELL SCH ATTN DIR OF DOC & LIT FT HOLABIRD
1 COMDT USA C&GSC OFC OF CHF OF RESIDENT INSTR FT LEAVENWORTH
1 COMDT USA CA SCH ATTN DEPT OF RSCH ANALYSIS & DOC FT GORDON
1 COMDT USA CA SCH ATTN DOI FT GORDON
1 COMDT USA CA SCH ATTN EDUC ADV FT GORDON
1 COMDT USA CA SCH ATTN LIB FT GORDON
1 COMDT USA SCH & TNG CTR ATTN ACOFS G3 TNG DIV FT MCCLELLAN
1 COMDT USA SCH & TNG CTR ATTN ACOFS G3 PLNS & OPS DIV FT MCCLELLAN
10 COMDT USA INST FOR MIL ASSIST ATTN DOI FT BRAGG
1 COMDT USA C9K WPNS ORIENTATION COURSE ATTN DOI DUGWAY UTAH
1 COMDT USA FLD ARTY SCH ATTN DOI FT SILL
1 COMDT USA ARTY & MSL SCH ATTN EDUC SERVICES DIV FT SILL
1 COMDT USA ARTY & MSL SCH ATTN EDUC ADV FT SILL
1 COMDT USA TRANS SCH ATTN DIR OF DOC & LIT FT EUSTIS
1 COMDT USA TRANS SCH ATTN LIB FT EUSTIS
1 USA INST FOR MIL ASST ATTN EDUC ADV FT BRAGG
1 COMDT ARMY QM SCH OFC DIR OF NONRESID ACTVY ATTN TNG MEDIA DIV VA
1 COMDT USA ARTY & MSL SCH ATTN LIB FT SILL
1 CG USA SCH & TNG CTR ATTN ACOFS G3 FT GORDON
1 COMDT USA AD SCH ATTN AKBAAS-CL-EA FT BLISS
2 DIR BRGD & BN OPNS DEPT USAIS FT BENNING
1 DIR COMM ELEC USAIS FT BENNING
1 DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
1 CG US ARMY SIGNAL CTR & SCH ATTN SIGDTL-3 (COBET II)
1 SECY OF ARMY, PENTAGON
1 DCS-PERS DA ATTN CHF C&S DIV
1 DIR OF PERS STUDIES & RSCH ODCSPER DA WASH DC
2 ACSFOR DA ATTN CHF TNG DIV WASH DC
1 CG USA MAT COMD ATTN AMCRD-TE
1 CHF OF ENGNRS DA ATTN ENGTE-T
1 HQ ARMY MAT COMD R&D DRCTE ATTN AMCRD-RC
2 CG ARMY MED R&D COMD ATTN BEHAV SCI RES BR
1 US ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN: CRD-AR
1 OPO PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) JPOMO
1 ARMY PROVOST MARSHAL GEN
1 DIR CIVIL AFFAIRS DRCTE CDCSOPS
1 OFC RESERVE COMPON DA
2 CG USA SEC AGCY ARL HALL STA ATTN AC OF S GI VA
50 ADMIN DOC ATTN: TCA (HEALY) CAMERON STA ALEX., VA. 22314
1 CO US ARMY MED RES LAB FT KNOX
1 CHF OF R&D DA ATTN CHF TECH & INDSTR LIAISON OFC
2 CG ARMY MED R&D COMD ATTN MEDDH-SR
1 U S ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN CRD-AIC
1 COMDT USA CBT SURVEIL SCH & TNG CTR ATT ED ADV FT HUACHUCA
1 COMDT USA CBT SURVEIL SCH & TNG CTR ATTN ORG DOC & NEW EQUIP ARIZ
2 TNG & DEVEL DIV ODCS-PERS
1 COMDT USA CBT SURVEIL SCH & TNG CTR ATTN 1ST CBT TNG BDE ARIZ
1 CAREER MGT BR ATTN P CETIENNE CAMERON STA ALEX VA
2 PRES ARMY ARMOR BD FT KNOX
1 PRES ARMY MAINT BD FT KNOX
2 PRES ARMY ARTY BD FT SILL
1 DPTY PRES ARMY MAT COMD BD ABERDEEN PG
15 CG USCONARC ATTN ATIT-RD-RC FT MONROE
2 CG USCONARC ATTN LIB FT MONROE
1 CO ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1 US ARMY ARCTIC TEST CTR H & D OFFICE SEATTLE
1 CHF USA AC HRU FT BLISS
1 CHF USA ARMOR HRU FT KNOX
1 CHF USA AVN HRU FT RUCKER
1 CHF USA INF HRU FT BENNING
1 CHF USA TNG CTR HRU PRES OF MONTEREY
10 CG 4TH ARMORED DIV ATTN DCSOT APO NY 09326
2 CO 16TH ARMOR GP FT. KNOX
5 CO 2D ARMORED CAV REGT APO 09696 NY
1 CO 3D ARMORED CAV REGT APO 09034 NY
4 CO 14TH ARMORED CAV REGT APO 09026 NY
2 CG ARMY ARMOR & ARTY FIRING CTR FT STEWART ATTN AC OF S TNG OFCR
1 1ST ARMORED DIV HQ & HQ CO FT HOOD ATTN AC OF S G2
10 CO 1ST BN 63RD ARMOR 1ST INF DIV ATTN S3 FT RILEY
8 CO 1ST BN 64TH ARMOR 3RD INF DIV ATTN S3 APO NY 09031
2 CO 1ST BN 73RD ARMOR 7TH INF DIV ATTN S3 APO SAN FRAN 96207
8 CO 2ND BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09034
1 CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV APO NY
1 CO 1ST BN 69TH ARMOR 4TH INF DIV ATTN S3 APO SAN FRAN 96262
1 CO 5TH BN 33D ARMOR ATTN S3 FT KNOX
1 CO 3RD BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09028
1 CO 3RD BN 37TH ARMOR 4TH ARMORED DIV ATTN S3 APO NY 09046
5 CO 2ND BN 34TH ARMOR 25TH INF DIV ATTN S3 APO SAN FRAN 96266
1 CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF S-3
1 55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
1 CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1 TEXAS NG 49TH ARMORED DIV DALLAS
1 CG ARMY ARMOR CTR FT KNOX ATTN G3 AIRBOT
2 CG 1ST INF DIV ATTN ACOFS G3 APO SAN FRAN 96345
1 CG 3RD INF DIV ATTN ACOFS G3 APO NY 09036
3 CG 4TH INF DIV ATTN ACOFS G3 APO SAN FRAN 96262
1 CG 7TH INF DIV ATT ACOFS G2 APO SAN FRAN 96207
1 CG 8TH INF DIV ATTN ACOFS G2 APO NY 09111
1 CG 5TH INF DIV (MECH) & FT CARSON ATTN ACOFS G2 COLO
5 CG 82ND ABN INF DIV ATTN ACOFS G4 FT BRAGG
1 CO 197TH INF BRGD FT BENNING ATTN S3
1 CO 1ST BN (REINF) ATTN S3 FT MYER
1 CO 3RD BN 6TH INF REGT ATTN S3 APO NY 09742
1 CO 171ST INF BDE ATTN S3 APO SEATTLE 98731
5 CG 25TH INF DIV APO 96225 SAN FRAN
1 CO 1ST BN 34TH INF 8TH INF DIV ATTN S3 APO NY 09034
1 CO 2ND BN 15TH INF 3RD INF DIV ATTN S3 APO NY 09028
5 CG 24TH INF DIV ATTN ACOFS G3 FT RILEY
6 CO 1ST BN (MECH) 52ND INF 198TH INF BDE ATTN S3 APO SAN FRAN 96217
2 CO 4TH BN (MECH) 54TH INF ATTN S3 FT KNOX
1 CO USA PACTIC GP USN TNG DEVICE CTR FLA
2 CONSOL RES GP 7TH PSYOP GP APO 96240 SAN FRAN
2 DA OFC OF ASST CHF OF STAFF FOR COMM-ELECT ATTN CFES-6 WASH
1 CG MILIT DIST OF WASHINGTON
1 SYS RES GP ENGNR EXPRM STA COLUMBUS O
1 DIR ARMY LIB PENTAGON
1 STRATEGIC PLANNING GP CORPS OF ENGNR ARMY MAP SERV
1 CHF OF MILIT HIST DA ATTN GEN REF BR
1 CO USA 10TH SPEC FORCES GP FT DEVENS
1 CO 24TH ARTY GP (AD) ATTN S3 FT
1 CG 31ST ARTY BDE AD ATTN S3 PA
1 CG 49TH ARTY GP AD ATTN S3 FT LAWTON
2 HQS 4TH BN 59TH ARTY REGT ATTN S3 NORFOLK
1 CO 2NTH ARTY GP AD ATTN S3 SELFRIDGE AFB
1 CG 52ND ARTY BDE AD ATTN S3 FT HANCOCK

1 HQS 45TH ARTY BDE AU ATTN S3 ARL HTS ILL
1 CG 101ST ABN DIV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 CG 1ST CAV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 US ARMY GEN EQUIP ATTN TECH LIB FT LEE
1 US ARMY TROPIC TEST CTR PO DRAWER 942 ATTN HEHAV SCIEN CZ
8 CG III CORPS & FT HOOD ATTN G3 SEC FT HOOD
30 CO 1ST ARMORED DIV ATTN G3 SEC FT HOOD
30 CG 2D ARMORED DIV ATTN G3 SEC FT HOOD
25 CO 13TH SUPT BGDE ATTN S3 SEC FT HOOD
10 CG USAFAC ATTN G3 SEC FT SILL
20 CO III CORPS ARTY ATTN G3 SEC FT SILL
20 CG USA AD CTR ATTN G3 SEC FT BLISS
3 CG ATTN G3 SEC FT POLK LA
1 BESO ARO OFC CHF OF R&D WASH DC
1 CHF OF R&D DA ATTN SCI INFO BR RSCH SPT DIV WASH DC
2 CINC US PACIFIC FLT FPO 96614 SAN FRAN
1 CINC US ATLANTIC FLT CODE 312A USN BASE NORFOLK
1 CDR TNG COMMAND US PACIFIC FLT SAN DIEGO
5 TECH LIB PERS LIB BUR OF NAV PERS ARL ANNEX
3 DIR PERS RES DIV BUR OF NAV PERS
1 TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1 HUMAN FACTORS BR PSYCHOL RES DIV ONR
1 ENGNR PSYCHOL BR ONR CODE 455 ATTN ASST HEAD WASH DC
3 CO + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1 CO FLT ANTI-AIR WARFARE TNG SAN DIEGO
1 CO NUCLEAR WEAPONS TNG CTR PACIFIC U S NAV AIR STA SAN DIEGO
2 CO FLT TNG CTR NAV BASE NEWPORT
1 CO FLEET TNG CTR U S NAV STA SAN DIEGO
1 CLIN PSYCHOL MENTAL HYGIENE UNIT US NAV ACAD ANNAPOLIS
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
2 CO + DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NORFOLK
2 CO FLT SONAR SCH KEY WEST
1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAV RES ATTN SPEC ASST FOR R & D
1 CHF OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
1 CHF OF NAV RES ATTN HEAD GP PSYCHOL BR CODE 452
1 DIR US NAV RES LAB ATTN CODE 5120
1 DIR NAVAL RSCH ATTN LIB CODE 2029 (ONRL) WASH DC
1 CHF OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CG MED FLD RES LAB CAMP LEJEUNE
1 CDR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
1 OIC NAV PERS RES ACTVY SAN DIEGO
1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
2 NAVAL MSL CTR (CODE 5342) PT MUGU CALIF
1 DIR PERS RES LAB NAV PERS PROGRAM SUPPORT ACTIVITY WASH NAV YD
1 NAV TNG PERS CTR NAV STA NAV YD ANNEX CODE 93 ATTN LIB WASH
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV OPNS OP-01P1
1 CHF OF NAVL OPS OP 037 WASH DC
1 CHF OF NAV OPNS OP-07T2
2 COMDT HQS 8TH NAV DIST ATTN EDUC ADV NEW ORLEANS
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OF NAV OPS OP03EG
2 COMDT PTP COAST GUARD HQ
1 CHF OFCR PERS RES + REVIEW BR COAST GUARD HQ
1 CO US COAST GUARD TNG CTR GOVERNORS ISLAND NY
1 CO US COAST GUARD TNG CTR CAPE MAY NJ
1 CO US COAST GUARD TNG CTR & SUP CTR ALAMEDA CALIF
1 CO US COAST GUARD INST OKLA CITY OKLA
1 CO US COAST GUARD RES TNG CTR YORKTOWN VA
1 SUPT US COAST GUARD ACAD NEW LONDON CONN
1 OPNS ANLS OFC HQ STRATEGIC AIR COMD OFFUTT AFB
1 AIR TNG COMD RANDOLPH AFB ATTN ATFTM
1 TECH DIR TECH TNG DIV(HRD) AFHRL LOWRY AFB COLO
1 CHF SCI DIV DRCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 CHF OF PERS RES BR DRCTE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF ANAL DIV (AFPOPL (R) DIR OF PERSONNEL PLANNING HQS USAF
1 HQ AFSC SCBB ANDREWS AFB
2 CDR ELEC SYS DIV L G HANSCOM FLD ATTN ESRHA BEDFORD MASS
1 HQ SAMSO (SMSIR) AF UNIT POST OFC LA AFS CALIF
2 MILIT TNG CTR OPE LACKLAND AFB
2 AFHRL (HRT) WRIGHT-PATTERSON AFB
1 AMD AMRH BROOK AFB TEXAS
1 HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
4 HQS ATC (ATCTO-M) RANDOLPH AFB TEXAS
1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTI
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
1 DIR OF LIB US AIR FORCE ACAD
1 COMDT DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 COMDT ATTN LIB DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PAT.
1 6570TH PERS RES LAB PRA-4 AEROSPACE MED DIV LACKLAND AFB
1 TECH TNG CTR (LMTC/OP-I-LI) LOWRY AFB
2 AF HUMAN RESOURCES LAB MRMTO WRIGHT-PATTERSON AFB
2 CO HUMAN RESOURCES LAB BROOKS AFB
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN TDL
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
5 CIA ATTN OCR/ADD STANDARD DIST
1 SYS EVAL DIV RES DIRECTORATE DOD-OCD PENTAGON
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF MGT & GEN TNG DIV TR 200 FAA WASH DC
1 BUR OF RES & ENGR US POST OFC DEPT ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR OE DEPT OF HEW ATTN T O CLEMENS
1 OFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC
1 DEPT OF TRANS FAA ACQ SEC HQ 610A WASH DC
1 SYS DEVEL CORP SANTA MONICA ATTN LIB
2 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RAC ATTN LIB MCLEAN VA
1 RAND CORP WASHINGTON ATTN LIB
1 DIR RAND CORP SANTA MONICA ATTN LIB
2 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 SIMULATION ENGR CORP ATTN DIR OF ENGR FAIRFAX VA

2 U OF PGH LEARNING R+D CTR ATTN DIR
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 RAYTHEON SERV CO ATTN LIBN BURLINGTON MASS
2 EDUC & TNG CONSULTANTS ATTN L C SILVERN LA
1 GEN DYNAMICS POMONA DIV ATTN LIB DIV CALIF
2 MARQUARDT INDSTR PROD LC CUCAMONGA CALIF
2 OTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 MGR BIOTECHNOLOGY AEROSPACE SYS DIV MS 8H-25 BOEING CO SEATTLE
2 CTR FOR RES IN SOCIAL SYS FLD OFC FT BRAGG
1 IDA RSCH & ENG SUPT DIV ARL VA
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 EDITOR TNG RES ABSTR AMER SOC OF TNG DIRS U OF TENN
1 CTR FOR RES IN SOCIAL SYS AMER U
5 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GS02 TNG
2 CANADIAN LIAISON OFCR ARMY ARMOR BD FT KNOX
3 AES FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
2 ARMY ATTACHE ROYAL SWEDISH EMBSY WASHINGTON
1 DEF RES MED LAB ONTARIO
3 AUSTRALIAN NAV ATTACHE EMBSY OF AUSTRALIA WASH DC
1 OFC OF AIR ATTACHE AUSTRALIAN EMBSY ATTN: T.A. NAVGN WASH. D.C.
2 AUSTRALIAN EMBSY OFC OF MILIT ATTACHE WASHINGTON
2 U OF SHEFFIELD DEPT OF PSYCHOL
1 MENNINGER FOUNDATION TOPEKA
1 AMER INST FOR RES SILVER SPRING
1 AMER INST FOR RES PGH ATTN LIBN
1 DIR PRIMATE LAB UNIV OF WIS MADISON
3 MATRIX CORP ALEXANDRIA ATTN TECH LIBN
1 AMER TEL+TEL CO NY
1 U OF GEORGIA DEPT OF PSYCHOL
1 DR GEORGE T HAUTY CHMN DEPT OF PSYCHOL U OF DEL
1 VITRO LABS SILVER SPRING MD ATTN LIBN
1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
1 TVA ATTN CHF LABOR RELATIONS BR DIV OF PERS KNOXVILLE
1 U OF GEORGIA DEPT OF PSYCHOL
1 GE CO WASH D C
1 AMER INST FOR RES PALO ALTO CALIF
1 MICH STATE U COLL OF SOC SCI
1 N MEX STATE U ATTN PROF OF PSYCHOL
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 NORTRONICS DIV OF NORTHROP CORP ANAHEIM CALIF
1 OHIO STATE U SCH OF AVN
1 SCI RSCH ASSOC INC DIR OF EVAL CHICAGO ILL
1 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 TUFTS U HUMAN ENGNR INFC + ANLS PROJ
1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 GEORGIA INST OF TECH DIR SCH OF PSYCHOL
1 ENGNR LIB FAIRCHILD HILLER REPUBLIC AVN DIV FARMINGDALE N Y
1 WASHINGTON ENGNR SERV CO INC KENSINGTON MD
1 LIFE SCI INC FT WORTH ATTN PRES
1 AMER BEHAV SCI CALIF
1 COLL OF WM + MARY SCH OF EDUC
1 SO ILLINOIS U DEPT OF PSYCHOL
2 COMMUNICABLE DISEASE CTR DEVEL + CONSULTATION SERV SECT ATLANTA
2 WASH MILITARY SYS DIV BETHESDA MD
1 NORTHWESTERN U DEPT OF INDSTR ENGNR
1 HONEYWELL ORD STA MAIL STA 806 MINN
1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 AEROSPACE SAFETY DIV U OF SOUTHERN CALIF LA
1 MR BRANDON B SMITH RES ASSOC U OF MINN
1 CTR FOR THE ADVANCED STUDY OF EDUC ADMIN U OF OREG
1 DR V ZACHERT RT 2 NORMAN PARK GA
1 J P LYDON DIR JR ROTC SAN ANTONIO TEXAS
1 DR E FOULKE DEPT OF PSYCH UNIV OF LOUISVILLE
1 DR E PERKINS PROF OF PSYCH ST CLOUD STATE COLL MINN
1 MR S AILES STEPTOE & JOHNSON WASH DC
1 DR W BEVAN VP & PROVOST THE JOHNS HOPKINS UNIV MD
1 DR W C BIEL U OF SOUTHERN CALIF LA
1 DR C W BRAY BOX 424 QUOGUE LI NY
1 MR J M CHRISTIE PRES RIGGS NATL BANK WASH DC
1 DR C W CLARK VP FOR RSCH RSCH TRIANGLE INST NC
1 GEN H P HARRIS (USA RET)PRES THE CITADEL SC
1 DR L T RADER CHMN DEPT OF ELEC ENGR U OF VA
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GEN LIB DOCU DEPT
1 FLORIDA STATE U LIB GIFTS + EXCH
1 PSYCHOL LIB HARVARD UNIV CAMBRIDGE
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U OF NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 SERIALS REC UNIV OF MINN MINNEAPOLIS
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL DH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
2 LIB GEO WASH UNIV ATTN SPEC COLL DEPT WASH DC
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U FARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 U OF LOUISVILLE LIB BELKNAP CAMPUS

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